THE UNIVERSITY OF BRITISH COLUMBIA
Health, Safety & Environment

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Lab Renovation and Design Planning Guide

Adapted from:

Document	Department	Created	Updated
"Renovation and Design Planning Guide for Laboratory Facilities"[1]	Campus Operations & Risk Management	August 2005	1. February 2012 (S. Kayfish) 2. November 2017 (C. Michels) 3. May 2022 (M. Torney)

BACKGROUND

The information and checklist has been adapted by Health, Safety & Environment to aid individuals who are involved in the design of new laboratory facilities or renovating existing facilities. Including all required items in the design stage is more economical than trying to correct omissions at a later date; therefore, please consider the information as an aid to designing an efficient complete laboratory.

CONSIDERATIONS

1. Laboratory Layout

- Rooms greater than 15 square meters in area or requiring a distance of travel greater than 4.5 meters from any point in the room to an exit door and in which explosive or easily ignited materials are used or stored must have two exits, preferably diagonally opposite one another. (Prudent practices)
- The area of the laboratory in which the hazardous operations occur shall be farthest from the exits. Hazardous operations shall not be performed in areas that will cut off sections of the lab from the exits. (Prudent practices)
- Desks and study areas shall be located close to the exits and away from hazardous areas and have clear delineation from active lab areas. (prudent practices)
- All areas of the room should be visible from the doorway with no "hidden" areas.
- (prudent practices)
- Safety stations containing safety equipment, fire extinguishers, first aid kits, emergency showers, spill kits, and telephones should be located near the exit. (Prudent practices)
- Fume hoods must be located away from exits and traffic patterns in the laboratory. Special attention must be given to the location of the supply air ducts to the room so that supply air does not disturb the flow of air around the fume hood. Desks should not be opposite fume hoods in case of explosions inside the fume hood. (Prudent practices)
- The ventilation layout should direct air movement from the least contaminated space (the entrance) to the most contaminated space (fume hood). (Prudent practices)
- Location of diffusers and air exhaust vents in a location and configuration where they do not disrupt protective air curtains associated with fume hoods and biological safety cabinets.

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- Special room layouts are required for laser laboratories and laboratories containing X-ray generating equipment or radiation emitting devices. Risk Management Services must be consulted. (Radiation Protection Act and Regulation, Federal Radiation Emitting devices Act.)
- Special consideration is to be given to the location of biological safety cabinets.
- RMS must be consulted. (Health Canada Canadian Biosafety Standard, Guidelines and Handbook.)

2. Personal Hygiene

The following items must be included:

- Hand soap and paper towel dispensers adjacent to a dedicated handwashing sink
- Health Canada Canadian Biosafety Standard, Guidelines and Handbook.)
- A place to store street clothes so that they remain free of contamination Health Canada Canadian Biosafety Standard, Guidelines and Handbook, Occupational Health and Safety Regulation, Canadian Nuclear Safety Commission Regulations.)
- Desk work areas separate from experimental set-ups (ideally outside the laboratory) (Prudent practices)
- Area for storage and consumption of food outside the laboratory (Health Canada Canadian Biosafety Standard, Guidelines and Handbook.), Occupational Health and Safety Regulation, Canadian Nuclear Safety Commission Regulations.)
- Hands free washing facilities for areas where biohazard are handled (Best practice)

3. Emergency Equipment

The following items must be included:

- Appropriate fire extinguisher installed on the wall near the main entrance to the laboratory. (Fire code)
- Space for first aid kit to be mounted on wall near the main entrance to the laboratory (Prudent practices)
- Eyewash station meets RMS risk assessment requirements - Occupational Health and Safety Regulation
- Safety shower meets HSE risk assessment requirements - Occupational Health and Safety Regulation
- Spill response supplies, based upon hazards in the laboratory (near the entrance to the laboratory)
- It is recommended that a safety station be designed to centralize emergency response equipment items. (Prudent practices)

3.1 Fixed area monitoring systems

The following may be required:

- Storage of large volumes of flammable liquids will require a separate fire suppression system
- Monitoring systems must be in place to detect certain toxic gases for example: H2S, Carbon Monoxide, Cyanide

- Oxygen level monitor
- Lower Explosive Limit (LEL) for large flammable storage areas

4. Hazardous Materials

A chemical fume hood is required if hazardous materials will be used. The fume hood interior liner must be resistant to the chemical vapours that will be present. A standard fume hood interior liner is made of stainless steel. Hydrochloric acid and nitric acid corrode stainless steel. Therefore, epoxy coatings or methyl methacrylate (i.e. Corian) should be the used as the interior liner of the fume hood which will be used for acids. Perchloric acid fume hoods must have a wash down system. CSA Standard Z316.5-2004 – "Fume Hoods and Associated Exhaust Systems",

Chemical storage must meet the following requirements:

- have separate storage for incompatible substances
- more hazardous chemicals located below eye level
- be made of material resistant to the chemicals stored (wood is a poor choice)
- discourage stacking of bottles, or containers being stored more than two deep on a shelf
- be designed such that containers cannot be pushed off the shelves ("no see through" shelves)
- be away from drains
- not block the aisles and exits
- be labelled with appropriate hazard warning stickers

4.1 Compressed Gases

The following are examples of compressed gases used in laboratories:

- Inert gases: nitrogen, helium, xenon, compressed air, and carbon dioxide Toxic gases: carbon monoxide, hydrogen cyanide, hydrogen sulphide & sulfur dioxide
- Corrosive gases: hydrogen chloride, anhydrous ammonia, oxygen Flammable gases: propane, hydrogen, and acetylene

The following will be required if compressed gases are to be used in the laboratory:

- storage locations for reserve cylinders, one spare cylinder for each type of gas used
- all cylinders must be secured to immovable objects (not attached to other utilities)
- consider the size of the cylinders, so that restraints can be placed at appropriate heights
- cylinders must not be stored within 2 metres of entrances to the laboratory
- gas cabinet with ventilation for toxic or corrosive gases
- monitoring systems must be in place to detect certain gases; for example, hydrogen sulphide, carbon monoxide. A SCBA or supplied air systems must also be available in the area
- further conditions must be followed if liquid oxygen is to be used (see OHS regulations)
- storage area for liquid nitrogen Dewars
- an oxygen level monitor may be required to prevent asphyxiation from occurring due to the venting and possible displacement of oxygen from large liquid nitrogen Dewars
- liquid nitrogen Dewars must be stored in a location away from the entrances to laboratory
- cylinders cannot be stored within 5 feet of an exit

4.2 Corrosives:

The following are examples of common corrosives used in laboratories:

- Alkaline corrosives: ammonium hydroxide, sodium hydroxide, anhydrous ammonia
- Acidic corrosives: hydrochloric acid, sulfuric acid, thionyl chloride, acetic acid, nitric acid

The following will be required if corrosives are to be used in the laboratory:

- separate corrosive storage cabinets for bases and acids
- separate storage for incompatible corrosives (i.e. nitric acid)
- eyewash station (Occupational Health and Safety Regulation)
- safety shower (Occupational Health and Safety Regulation)
- special requirements for Hydrofluoric acid use and storage
- use of perchloric acid in special fumehoods (if performing heating or digestions or using concentrated acid) (Occupational Health and Safety Regulation & best practices)
- self-contained breathing apparatus will be required if large quantities of anhydrous ammonia will be used

4.3 Flammable Liquids:

The following are examples of flammable liquids used in laboratories:

- acetone
- ethyl alcohol (ethanol)
- methyl alcohol (methanol)
- diethyl ether
- acetonitrile

The following will be required if flammable liquids are to be used in the laboratory:

- storage in compliance with all applicable codes; including the use of solvent storage cabinets, solvent safety cans, and container size limitations
- flammable storage cabinet located at least 5 feet from any entrances or exit routes
- flammable storage cabinet is required if more than 10 litres will be in a laboratory at any one time
- the flammable storage cabinet must be grounded
- a water flow monitor and temperature override system may be necessary if flammable liquids are to be heated
- approved flammable storage refrigerators and freezers must be used for temperature sensitive materials (these appliances should have emergency power supply if materials could become explosive if heated above 4 degrees).
- flammable-rated equipment such as heating blocks and stirrers
- ventilated workspace for special equipment such as Rotovaps or distillation apparatus
- fume hoods are required for the general use of solvents

4.4 Highly Toxic Substances and Controlled Substances:

The following are examples of highly toxic and controlled substances used in laboratories:

- Highly toxic substances: potassium cyanide, aluminium phosphide

- Controlled substances: barbital, testosterone, codeine, and absolute alcohol (100% or 99% ethanol)

The following will be required if highly toxic substances or controlled substances are to be used in the laboratory:

- lockable storage
- the storage cabinet must be a metal cabinet

4.5 Pyrophoric materials:

The following are examples of pyrophorics used in laboratories:

- sodium metal
- white phosphorus
- finely divided aluminium
- diethyl zinc

The following may be required if pyrophoric materials are to be used in the laboratory:

- glove box or other method of excluding air from pyrophoric materials
- provision for inert gas cylinder storage and attachment at least 2 meters away from entrances

4.6 Oxidizers:

The following are examples of oxidizers used in laboratories:

- calcium hypochlorite
- chromic acid
- hydrogen peroxide
- manganese dioxide
- perchloric acid
- potassium bromate
- lead nitrate
- sodium perchlorate

The following will be required if oxidizers are to be used in the laboratory:

- segregated storage away from flammable materials (BC Fire Code)
- separate storage for incompatible oxidizers
- special installation required if liquid oxygen is used

4.7 Biohazardous materials:

The following be required if biohazardous materials* are to be used or stored in the laboratory:

- consultation with HSE
- reference the latest version of Health Canada Canadian Biosafety Standard, Guidelines and Handbook for a complete description of the physical requirements
- reference the latest version applicable guidelines for the Canadian Food Inspection Agency's "Containment Standards" for plant pests, aquatic pathogens
- a single source location for both CFIA and the Public Health Agency of Canada's various Standards, Guidelines, and Handbook is found on the Government of Canada's Canadian Biosafety Standards and Guidelines at https://www.canada.ca/en/public-health/services/canadian-biosafety-standards-guidelines.html
- Biological Safety Cabinet (BSC) (may or may not require external exhaust)

- Once a BSC is installed it must be certified and cannot be moved thereafter without further recertification
- Dedicated hand washing sink near exit (Best practice & Public Health Agency of Canada Biosafety Standards and Guidelines0)

* Any of the following listed materials are considered biohazardous

- level 2 or higher biohazardous materials as defined by Health Canada
- level 2 or higher biohazardous materials as defined by Canadian Food Inspection Agency
- human tissues and body fluids (including sewage)
- certain animal tissues and body fluids

4.8 Radioactive materials:

The following will be required if radioactive materials are to be used in the laboratory:

- consultation with HSE
- reference the Design Guide for Basic and Intermediate Level Radioisotope Laboratories, Canadian Nuclear Safety Commission Regulations.
- reference the University of British Columbia, Okanagan “Radiation Safety and Procedures Manual”

4.9 Radiation emitting devices:

The following will be required if radiation-emitting devices are to be used in the laboratory:

- consultation with HSE
- certain x-ray systems may require supplemental room shielding
- ANSI standards must be followed when class 3b and 4 lasers are used

5. Waste Management

Hazardous wastes

- provisions must be made for the accumulation and safe storage of hazardous wastes; for example, safety cans
- waste must not be placed within 2 metres of laboratory exits
- wastes must be stored so that they do not block aisles
- fume hoods must not be used for waste storage unless specifically designed and solely used for that purpose

Biohazardous wastes

- provisions must be made for the accumulation and storage of the biohazardous wastes.

Non-hazardous waste

- provisions must be made for the accumulation and disposal of non-hazardous waste

- adequate space must be allotted for the waste containers so that they do not block aisles or doors
- laboratory recycling is permitted through the Sustainability Office's Laboratory Recycling program and Health, Safety & Environment's Hazardous Waste program (recyclable glass) on campus

6. Utilities

The utility locations within the laboratory require prior layout to allow for proper equipment placement. The points listed below need to be considered:

6.1 Electricity:

- equipment requiring 120 V lines
- equipment requiring 220 V lines
- equipment requiring higher voltage
- equipment requiring separate circuits; for example, refrigerators, and computer
- equipment requiring direct wiring; for example, muffle furnaces
- task lighting requirements (lighting should meet Occupational Health and Safety requirements that relate to the specific taks)
- emergency shut-off, if required, is located near the main entrance to the lab, marked or labelled as **Emergency Shutoff for Utility (natural gas) or Piece of equipment**
- ground-fault circuit interrupters (GFCI)
- locations of electrical plugs with respect to specific equipment locations; for example, wall, floor, or ceiling

All equipment must have CSA (Canadian Standards Association) or ULC (Underwriters Laboratory Canada) approval. Alternate standards may be considered with permission from Technical Safety BC.

6.2 Water:

- types of water service (hot, cold, de-ionized) and location (confirm incoming water quality needed for machines and instruments as additional treatment may be needed.
- location and size of wash up sinks
- location of cup sinks
- floor drains if required; for example, ice machines or dishwashers
- equipment that requires water; for example, ice machines, dishwashers
- equipment that requires water for cooling purposes
- location of demineralizing water units (Milli-Q)
- location of water aspiration set-ups
- location of water stills
- while it is not permitted to put hazardous materials into drains, accentual release happens on occasion. Consider if blue resistant plumbing is prudent given lab activities

- drains may need soil or paint collection devices to prevent these materials from entering the waste water system

6.3 Steam:

- portable steam baths
- steam heated equipment; for example, autoclaves
- drain lines for steam heated equipment

6.4 Natural gas:

- gas-fired appliances requiring venting; for example, atomic absorption spectrophotometers
- microbiological work requiring flames
- location of Bunsen burner work areas (consider height of surrounding shelving and other materials

6.5 Vacuum lines:

- location of vacuum line in respect to equipment requiring vacuum
- traps to prevent vapours or aerosols from entering the vacuum lines within the building system

6.6 Low Pressure Air from building system:

- location of equipment that requires low pressure air
- what pressure and volume of air is required

6.7 Telephone and Computer Network Cable:

- location of telephone set (wall or desk model)
- location of computer network cables
- labs handling hazardous materials should have an emergency lab safety telephone (no external line needed) in collaboration with IT Services

6.8 Equipment Communication:

- is there a need for communication cables between equipment in one laboratory and another laboratory or an office location, installation must be according to University Standards?
- are cable trays required within the laboratory?

6.9 Special lighting requirements:

- absence of light; for example, microscopy set-ups
- presence of special lights; for example, Xenon, UV, etc. and matching protective enclosures and interlocks as needed
- exterior warning lights may be needed for some LASERS or sensitive equipment

7.0 Material Storage

The following items should be considered when evaluating storage needs:

- disposable lab supplies; for example, test tubes, Kimwipe, scintillation vials, gloves, etc.
- personal items; for example, coats, shoes, winter boots, lab coats, and handbags
- seasonal equipment and supplies
- reference materials; for example, books, catalogues, and papers
- space to store step stool for accessing higher shelves, which are not above lab benches
- space to keep "street" clothes separate from work clothes
- open-end shelving is unsuitable for the storage of most items
- shelving must be designed for the weight of the objects on them
- shelves must be accessible and not installed up to ceiling height 18-inch clearance between the sprinkler height and the stored materials
- occupants should allow no more than two shelves over lab benches
- storage of items in the hallways and stairwells is prohibited (BC Fire Code)
- occupants should consider the "just-in-time" delivery system to avoid stockpiling lab items for which there is inadequate space and accessibility

8.0 Material Handling

- space to store a cart used to move items within the building
- space to store cryogenic dewers
- identified space to store empty cylinders
- gas cylinder cart

9.0 Ventilation

9.1 Fume hood:

All new fume hoods must have the features specified in UBC Technical Guidelines and be approved by RMS. Some of the variables in fume hood selection include:

- width - from two feet to eight feet. Two-foot fume hoods are not recommended as they generally lack adequate workspace. The standard on campus is a six-foot fume hood
- height - benchtop, knee-height, or floor-model hoods
- interior lining material - stainless steel, cement board, epoxy-coated cement board, solid polymer choice depends on materials to be used in the hood (example: stainless steel is a poor choice when using hydrochloric acid)
- utilities - water, gas, steam, compressed air, vacuum
- explosion-proof - electrical connections to conform to the Electrical Code for hazardous atmosphere used in laboratories where a hazardous atmosphere would exist
- perchloric acid use (heating, digestion and high concentrations)
- permanent equipment installation

9.2 Other ventilation options:

- slot hoods
- canopy hoods

- flexible fume extractors to provide "local" exhaust at the workbench or over special processes – Elephant trunks
- no filtered fume hoods have been approved for installation within British Columbia (Occupational Health and Safety Regulation)

9.3 Equipment requiring local exhaust: reason for exhaust requirements in brackets

- atomic absorption spectrophotometer (combustion products)
- muffle furnace (heat)
- curing oven (vapours, heat)
- rotovaps (flammable, volatile vapours)
- solvent distillation units (flammable, volatile vapours)
- tissue fixers (flammable, volatile vapours)
- steam autoclave (heat, moisture, and odours)
- ethylene Oxide sterilisation units (vapours)
- digestion units (corrosive vapours)
- fat extraction units (flammable, volatile vapours)
- printing plate acid baths (corrosive vapours)
- histological staining trays (flammable, volatile vapours)

9.4 Examples of processes requiring local exhaust:

- welding
- solvent extractions
- any use of toxic, corrosive, or flammable gases
- use of materials with a noxious odour
- use of materials, which are sensitizers or lachrymators
- use of volatile flammable materials
- spraying of hazardous materials (paint, pesticides)
- processes which generate hazardous dusts or aerosols
- anaesthesia
- use of materials that are very poisonous or IRAC known carcinogens

10 Spill Response

Hazardous material spill response:

- floor and sink drains including fumehood drains protected from hazardous material discharges, for example, if there is equipment which pumps or circulates hazardous liquids ethylene glycol, mercury, solvent stills, etc
- space allotted for spill response clean-up kit. (near the entrance to the laboratory)

Floods:

- sinks designed for overflow protection

- equipment which uses large amounts of water is there a provision for the removal of the water in case of flooding (ie catch pans, drain lines or similar).
- eye wash stations – into a sink or near a floor drain
- emergency showers – floor drains

Please contact HSE if you have any questions or concerns